Clinical Update

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National Naval Medical Center
8901 Wisconsin Ave
Bethesda, Maryland 20889-5600

Vol. 29 , No. 7 2007

Impression materials for fixed restorations

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Introduction

A variety of impression materials exists in order to capture the surface detail and dimensions of hard and soft tissues. The accuracy of an impression material is significant because it is essential for the fabrication of a well fitting removable and fixed prosthesis. Some current materials were developed from non-dental-related fields, such as materials created as alternatives to natural rubber or agar during World War II. [1, 2] To achieve a successful fixed impression, many factors must be considered, such as preparation design, location of margins, tissue retraction, fluid control, tray shape and design, and impression material. Today's impression materials can be evaluated on multiple levels, to include fluidity, set time, distortion, dimensional stability, biocompatibility, number of pours for the impression, and cost effectiveness. The purpose of this update is to discuss different impression materials commonly used for fixed prostheses.

Criteria for selection

The ideal impression material should possess multiple characteristics. One quality is the material's hydrophilicity, which is defined as having a high affinity for moisture, providing good surface wetting, and allowing for greater surface detail.[3] Another is the dimensional stability of the material, which is critical for accurate replication of the intraoral structures. Dimensional changes may occur due to contraction from polymerization, liberation of a by-product or accelerator component, water absorption from a wet or humid environment, or a change in temperature. Materials with good dimensional stability can remain unchanged for a period of approximately 7 days and resist temperature extremes during shipping.[3] Other qualities include tear resistance and elastic recovery. These are important for preserving the accuracy of the impression during removal from the mouth and after cast separations. Materials with sufficient tear resistance and elastic recovery will withstand multiple pours. Permanent deformation can occur when the polymer is elongated beyond the point where elastic recovery is possible. Permanent deformation is related to the degree of cross linking of the polymer strands, temperature, and the rate of the applied stress.[3] Another desired quality is the mechanism of shear thinning, which is the ability of a material to become more fluid when under a shearing force.[4] This quality is desired because it allows a low viscosity material to be placed at the margin of a preparation with a syringe, while permitting the same material, yet in a more viscous state, to be used as the tray material.[4] Other properties for an ideal material would include the ability to provide a high level of surface detail reproduction, ability to be disinfected without loss of detail and accuracy,[3] pleasant odor and taste, non irritating, adequate shelf life, economical, and easy to use.[4] Although nothing fills all criteria, a practitioner can wisely choose a material for a specific clinical situation.

Elastomeric impression materials

Polyvinyl siloxane (PVS) – These materials have been on the market since the mid 1970s. They have excellent detail reproduction and elastic recovery. They are dimensionally stable, odorless, tasteless, and exist in variable viscosities, rigidness, working and setting time.[5] Addition and condensation silicones are the two forms of polyvinyl siloxane materials.

Addition silicone – This material is generally referred to as polyvinyl siloxane or vinyl polysiloxane, and it is the most popular category of impression materials for fixed restorations.[2] They have excellent accuracy, tear resistance, dimensional stability, as well as a neutral odor and taste, and they are available in different viscosities. Addition silicones do have disadvantages. First is the hydrophobicity of the material. Any distortion or loss of detail is most likely caused by moisture present at the site to be impressed.[2] Second, an interaction with latex may cause inhibition of polymerization of the impression material. This may be observed as a film of unset material in isolated areas, or the presence of a sticky, slippery substance on the surface of the impression.[5] Third, it has been reported that the production of hydrogen gas from the impression causes voids on the surface of gypsum dies when poured immediately. Most manufacturers have eliminated the gas production from occurring, and it is no longer necessary to wait for one hour before pouring impressions.[6] Unless it is certain that hydrogen gas is not released, it is recommended that one wait at least 30 minutes to an hour before pouring.[2, 4]

All polymerization by-products are consumed or added to the setting reaction, and result in less polymerization shrinkage and increased dimensional stability. Multiple accurate casts may be routinely poured. The working times range from 3-6 minutes. The longer setting material may be useful for multiple teeth to full arch impressions when more working time is desired, while the faster setting material may be more useful for single unit impressions. The addition silicones are less rigid than polyethers when set. Tear strength can vary with different products, and varying temperature to adjust the working time is recommended. These products have the lowest distortion of any impression material. Easily disinfected and dimensionally stable for up to 7 days, this material is often the product of choice.[7]

Examples: Flexitime Heraeus Kulzer, Flexitime® Xtreme Heraeus Kulzer), Exafast (GC America), Examix (GC America), Extrude (Kerr), Reprosil (Caulk Dentsply), Aquasil (Caulk Dentsply, Imprint (3M ESPE), Express (3M ESPE).

Hydrophilized addition silicone[4] is another type of an addition silicone. It is made by the addition of surfactants to improve the moisture compatibility.[7] It is thought that the surfactant allows the impression material to wet the soft tissue, which results in a better impression, as well as facilitates pouring the gypsum model.[2, 4] These materials still require a dry field, but reproduce soft tissue surfaces accurately.[2] It has yet to be proven that surfactants containing PVS materials have a better wetability than polyether-based impression materials, but some recommend that the less hydrophobic behavior of the surfactant PVS may provide a significant advantage.[8]

Examples: StandOut (Kerr), Hydrosil (Caulk Dentsply).

Condensation silicone – During the setting reaction of this material, ethyl alcohol is a by-product. Its evaporation results in the contrac-

tion of the set impression, resulting in an inaccurate gypsum product for restoration fabrication.[2] Also, this material is hydrophobic, has poor dimensional stability and elastic recovery. Due to the significant volumetric changes during polymerization, a two-step technique is recommended to maintain a minimum thickness of low-viscosity material. Although condensation silicones tend to be cheaper, there is no advantage over other PVS materials.[7]
Examples: Speedex (Coltene/Whaledent), Primasil (TISS Dental), Accoe (GC-America), Cuttersil (Heraeus Kuler).

Polyether – These materials are very popular due to their inherent hydrophilic property and enhanced wetting ability. Developed in the 1960s, they produce no volatile by-product, and the polymerization reaction results in very low polymerization shrinkage, to result in long term dimensional stability, which may be useful when immediate pouring is not possible. Multiple accurate casts may be produced. It will absorb water and should not be immersed in liquid for an extended period of time. These materials are very accurate and have excellent elastic recovery. They are dimensionally stable up to 7 days if kept dry. Disadvantages include unpleasant taste and stiff set, which may make removal and cast separation difficult when undercuts are present.[7]
Example: Impregum (3M ESPE).
Some polyethers have been reformulated to maintain their hydrophilic properties and accuracy yet do not have the disadvantages of smell or extreme rigidity. Example: Permadyne (3M ESPE).
A new generation of polyether material, considered a hybrid material of PVS and PE, has some advantages of addition reaction silicones.[7,9] It maintains its hydrophilic properties, but is chemically altered to avoid the reactions responsible for the unpleasant taste. Additionally, it is less susceptible to moisture absorption, so it may be immersed for disinfection. The material is more flexible and therefore facilitates easier removal.[7]
Examples: P2 Next Generation Polyether (Heraeus Kulzer), Polyjel (Caulk Dentsply), SENN™ (GC America).

Polysulfide – Commonly referred to as rubber base, this material is not as accurate as PVS or PE. Impressions must be poured in less than one hour. High temperature and humidity reduce the working time. Detail reproduction is good and polymerization contraction is minimal. A custom tray is required because of its minimal rigidity when setting. This material does have a high tear resistance, but does not recover well from deformation. Disadvantages include bad odor and taste, long setting time, difficulty with handling, and it is unlikely that an impression can be poured more than once.[7]
Examples: Omniflex (GC America), Coe-Flex (GC America), Permlastic (Kerr), Neo-plex (Heraeus Kulzer).

Non-elastomeric impression materials
Reversible hydrocolloid – Introduced in 1937, reversible hydrocolloid is useful because of its hydrophilicity. Impressions may be made with blood and moisture in the field, and it is extremely accurate. Disadvantages include that it dehydrates quickly, and therefore does not have good dimensional stability and impressions must be poured immediately. It has low tear resistance, poor elastic recovery, and multiple pours are not possible from the same impression.[7] Additionally, the armamentarium required for this material involves specific syringes and heaters.[2]
This material can be recommended for single units and fixed partial dentures, but is better served as preliminary impression material for fabrication of provisional restorations or study models.[2]
Examples: Identic Syringable (Dux Dental), Acculoid (Van R).

Irreversible hydrocolloid – This material is successful for impressions because it is easy to use, generally comfortable for the patient, and inexpensive.[2] The powder should be weighed, not measured by volume. A method of making irreversible hydrocolloid impressions for fixed prosthodontics was introduced in the 1950s.[10] However, due to the availability of current impression materials, irreversible hydrocolloid is not recommended for fixed prostheses impressions. This material is recommended for impressions for diagnostic casts and removable partial dentures.[2]
Examples: Jeltrate (Dentsply), Identic (Cadco), Algi-X (Svedia Dental Industri AB).

Shelf life
The shelf life of all impression materials does not deteriorate significantly when in a tube or container and stored in a dry, cool environment. All containers should be kept tightly closed or resealed when possible, and expiration dates should be adhered to. It is best not to stock more than a year's supply of material.[2]

Conclusion
To create a successful fixed impression, the properties discussed must come into consideration when deciding what material to use. All of the presented materials have advantages and disadvantages that may be significant, depending on the clinical situation.

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